CO_2 PUMPING SYSTEM FOR MARS ISRU: ADVANCED ABSORBENT MATERIALS. Mike Reddig and Allen MacKnight, AlliedSignal Aerospace Systems and Equipment, M/S TOR-36-1-93140, 2525 W. 190th Street, Torrance California 90504-6099, USA. (macknia@tormp103.allied.com)

ABSTRACT: A conceptual system design is presented for the CO_2 pumping and pressurization requirements for Mars Propellant Production Facility. The system utilizes CO_2 absorbent materials that are cyclically absorbed and desorbed thermally. The system is designed to use Mars ambient pressure and temperature and deliver 1 kg/day CO_2 at 14.7 psia.

The system consists of 3 beds, inlet valves, a control system, heater and cooler, and a valve module. Each bed is 50 in^3 in volume and weighs 1.3 lbs not including the container. The desorption energy requirement is 40–48 W-hr. Valving includes inlet valves to the chemical pumps a delivery regulating valve and a valve module for cycling the desorption process. System operation has one bed absorbing CO_2, one bed Desorbing CO_2 (heating) and one bed cooling. Active temperature control of the beds is considered in order to minimize the bed size and allow for thermal integration with the balance of the system. For example use of waste heat from a Sabatier reactor. System schematic and functional diagrams are presented.

Table 1. Candidate Sorbent Performance Comparison

Sorbent Type	Mass Capacity, g CO_2/100 g	Volumetric Capacity, g CO_2/100 cu cm
Hydrophobic FCMS	**2.55**	**2.04**
Hydrophilic zeolite	**1.15**	**0.92**
Solid amine	**1.07**	**0.60**

Diffusion analysis at Mars ambient pressure have shown a bed absorption time of only 30 minutes is required for complete saturation. System sizing is dependent upon the specific absorption capacity and temperature coefficients of the sorbent materials. The specific capacities of several candidate sorbents are given in Table 1. The sorbents are Zeolite Molecular Sieve 13X, Solid Amine and AlliedSignal Carbon Molecular Sieve (CMS). A comparison of CO_2 sorbent pumping with these candidates is presented.

Fig. 1. Pelletized AlliedSignal CMS sorbent.

The AlliedSignal CMS (shown in Fig. 1) is prepared using a patented process and has demonstrated superior carbon dioxide absorption performance. It combines the attractive features of light weight and high capacity. It is currently being developed in support of a NASA research grant studying CO_2 removal from a crewed spacecraft with carbon molecular sieves. The program includes engineering scale tests on a variety of beds which will lead to a flight prototype.